measurement of time with atomic frequency standards. This particular reviewer finds astonishing the omission of the subject of optical double resonance and pumping and its relation to the measurement, at least, of excited-state and ion hyperfine measurements, even though there is included a brief description of level-crossing spectroscopy. Thus, in summary, it is probably correct to say that the more general articles are rather thin and brief and that the real value of the book is in the specialized contributions.

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Environmental Analysis

Light as an Ecological Factor. British Ecological Society Symposium No. 6, Cambridge, March–April 1965. RICHARD BAINBRIDGE, G. CLIFFORD EVANS, and OLIVER RACKHAM, Eds. Wiley, New York, 1967. 464 pp., illus. $13.50.

This symposium reflects the increasing interest of ecologists in quantitative measurement of environmental components while at the same time they are increasingly bringing the principles of systems analysis to bear on the study of environment as a whole. Obviously the demand for informational synthesis, along with increasingly better instrumentation, is providing unusual opportunities for analysis of the aquatic, terrestrial, and space environments. Although the representation of subjects in the individual papers of the symposium is partly fortuitous, most of the topics considered are presented in remarkable breadth and depth. The treatment of the topics is, of course, uneven. The papers are substantially enhanced by the inclusion of selected aspects of the discussions which followed their presentation at the symposium.

As the editors point out in their introduction, the symposium centered its attention successively upon (i) the light climate, broadly considered; (ii) micrometeorology and methods of light measurement and characterization in the open; (iii) problems of measurement and instrumentation; (iv) the light climate in forest communities; (v) light in the sea and rivers, including effects on pigmentation, growth and movement of organisms, penetration, scattering, and contrast perception, ocular sensitivity, and submarine visibility.

An excellent background paper on general principles of radiation meteorology by Collingbourne introduces the volume. Collingbourne calls attention to the growing availability to ecologists of good radiation data from national networks. Where field measurements of light are to be made, workers are urged to use instruments that can be calibrated against acceptable standards. The recommendation is soundly made that, where appropriate, photometric measurements be replaced by radiometric ones in which filters are used to isolate desired regions of the spectrum.

Light measurement and characterization in plant communities and in water occupy about 80 pages. About 140 pages are devoted to light and plant growth and condition, including diseases. The next 10 pages present an examination of the role of light in echinoid coloration, movement, reproduction, covering reaction, and dermal photosensitivity. Light influences on zonation in periwinkles and marine algae are given about 40 pages, and light-induced behavioral and cytological changes in a diatom about 20. Underwater visibility, vision, and visual feeding (of herring) are treated in about 50 pages. The last dozen pages of text report on demonstrations—of data-logging equipment, turgidity of plants in open and shaded habitats, solarimeters, herring larvae, bimetallic actinograph, hemispherical photography, light climate surveying apparatus, radiation recorder, and thermopiles for measuring field surface temperatures.

Most students of light in ecosystems and in plant and animal physiology and behavior will find information or references of use in this volume; it is equally true that they will conclude that much of what is being studied or is known on the subject is not included. Publication of this volume is particularly timely because of the concern of the International Biological Programme with the measurement of organic production in the terrestrial and aquatic spheres.

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Social Research for Social Practice

Methods for Experimental Social Innovation. GEORGE W. FAIRWEATHER. Wiley, New York, 1967. 262 pp., illus. $7.95.

In the 1960's social scientists have been moving into the arena of social action in greater and greater numbers, and as they move they are beginning to define and develop a new field which could be called "social engineering." Fairweather is a part of this movement. He believes that the social scientists can and should foster social progress by designing and evaluating new solutions to major social problems in carefully controlled field experiments.

This book has two primary objectives: the first is to present an argument for this special approach to social engineering, which Fairweather calls the "social innovative experiment," and the second is to offer a methodology or how-to-do-it manual for those who would accept this argument and follow his path. It would seem to this reviewer that the author succeeds better with the first than with the second objective.

Fairweather thinks that the social scientist should work with the practitioner to define significant social problems and a range of possible solutions, together with appropriate and consensually established criteria for outcome that are "acceptable and meaningful for those who are acquainted with the problem." Beyond this, however, compromise with the practitioner's needs and values is strictly out of order. The researcher should exercise strict control over the experiment, following such traditional canons of methodology as random assignment of subjects to experimental and control conditions, control on all potentially confounding variables, and stringently conservative interpretation of results (". . . a .001 level one-tailed test should be established as the acceptable level for recommending changes"). Although this scientific tough-mindedness might be useful as an antidote to the looseness and vagueness of much that passes as social action research, it is probably unrealistic and even inappropriate in many settings. Action research is necessarily a collaborative activity between research and practice to an extent which severely restricts the application of traditional research methodology.

As a methods handbook the would-be social-innovation experimenter will probably find this work inadequate.

With the possible exception of the coverage of Tryon's cluster analysis, most researchers will find the treatment very sketchy and elementary (for example, "Correlations do not reveal causation but the degrees of association"). In no case is the coverage sufficient to make reference to the standard methods texts unnecessary. Furthermore, specific examples are nearly always drawn from the author's own research in the rehabilitation of mental patients. A broader selection of problems, situations, and settings would have greatly enhanced the value of this work as a general reference. The book would also be enriched by more references to other traditions of action research, for example, to the classic studies of Elton Mayo and to the many which grew from the pioneering work of Kurt Lewin. There is a vast array of possible strategies for conducting social action research, and a comparison among them would have enlivened and sharpened the author's special viewpoint.

The concluding chapter, which describes the type of center ideally suited for carrying out and disseminating this research, provides some useful ideas on what kind of institutional arrangements we should be building into our society to create effective linkage between social research and social practice. It is in urging social scientists to think upon such issues that Fairweather's book makes its mark. Taken as a whole, it adds to our understanding of how to advance with rational and steady steps toward a better society.

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Insulators and Semiconductors

The Optical Properties of Solids. Course 34, International School of Physics "Enrico Fermi," 1965. J. TAUC, Ed. Academic Press, New York, 1966. 448 pp., illus. $22.

This volume is one of a kind that is now familiar; it consists of lectures given at a summer school. Such a presentation has both advantages and defects. It cannot be the careful, orderly, and lucid presentation that characterizes the best textbooks of a more or less stable discipline. What it can do is to bring into focus a field that has been developing rapidly. The present volume does indeed concern itself with such a field—the intrinsic optical properties of insulators and semiconductors.

Band theory has been developed in studies of the simpler semiconductors and is now being applied to the more difficult problems of compounds. In this volume rare gas solids, alkali halides, silver halides, and zinc sulfide type materials are treated along with the classic subjects of germanium and silicon.

Similarly, experimental sophistication has increased. In addition to simple transmission and absorption, there are now a large variety of photoemission, magneto-optic, piezo-optic, and electro-optic effects that are being exploited. These are described here. When alternating fields are used and the effects observed with phase-sensitive detectors, a vastly increased sensitivity is possible.

This book provides an extensive summary of these developments and is unique in doing so. Having it will be a necessity for those working or planning to work in this field.

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The Life of the Elasmobranchs

Sharks, Skates, and Rays. A symposium, Bimini, Bahamas, January–February 1966. PERRY W. GILBERT, ROBERT F. MATHEWSON, and DAVID P. RALL, Eds. Johns Hopkins Press, Baltimore, 1967. 640 pp., illus. $15.

Since Darwin, the comparative method has provided by far the most significant approach to biological problems, but recognizing the existence of phylogenies has made comparisons more difficult as well as rewarding. Animals are similar because they are related, and animals are related because they are similar. To avoid circular reasoning, all possible anchor points must be utilized. Paleontological data provide the best of these, but increasing the number of units to be compared also helps. This volume abundantly shows that the elasmobranchs are not just another kind of fish but a distinct type of vertebrate, nearly as different from the bony fishes as from the tetrapods, and capable of furnishing an additional dimension, so to speak, to the disciplines of comparative anatomy, physiology, and behavior. The book resulted from an interdisciplinary symposium on "Current Investigations Dealing with Elasmobranch Biology," held at the Lerner Marine Laboratory in 1966, which was noteworthy for the cross-fertilization of ideas it brought about.

The book begins with an authoritative review of the evolution of the elasmobranchs that should improve the perspective of those comparative physiologists and teachers who still insist on considering the sharks and their relatives to be the ancestors of the mammals and bony fish. The elasmobranchs became separated from the other lines of vertebrate phylogeny 400 million years ago, at about the same time the bony fish first evolved and long before the mammals and teleosts made their appearance. Systematists and laboratory instructors who have found little of interest in the uniform-appearing exterior of dogfishes and other sharks are due for a surprise when they read the chapters describing the several types of scales, the spines, hooks, spurs, and gaffs, and the elaborate array of sensory pit organs distributed over the bodies of these fish. Other surprising aspects of the lives of sharks turn out to be the complexity of their social relations, their migrations, and the rapidity with which they regularly replace their teeth. That elasmobranchs have complex nervous systems and sense organs is hardly unexpected, but recent studies on the histology and biochemistry of the brain, the morphology and physiology of the eye, and responses to chemical stimulation are noteworthy for the variety of techniques used, some of them specially adapted for handling such awkwardly large and dangerously strong subjects. Flourishing investigations on the electric organs of the bony fishes have revealed an amazing variety of structure and function; the organs of the torpedoes and skates may not be as varied, but they, too, exhibit exceptional properties that defy present explanation while offering exciting future possibilities.

Half of the book concerns comparative physiological and biochemical studies. Elasmobranchs differ distinctly from mammals in the types of proteins and enzymes of their body fluids, respiratory response to hypoxemia, level of blood lactic acid under stress, drug